Researching nurses' use of digital technology during the COVID-19 pandemic

Nurses' adoption and use of digital technology during the COVID-19 pandemic

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Abstract

Aim: to explore nurses' adoption and use of digital technologies during the COVID-19 pandemic

Methods: online survey to obtain nurses' feedback and ratings of technologies implemented and used to support patient care during the COVID-19 pandemic. Survey questions comprised fixed response and free-text questions and a rating of system usability (quantitative and qualitative data). Participants were recruited via nursing networks and social media.

Results: 55 respondents provided details on 85 separate technologies. The majority of technologies were used for patient monitoring/data sharing (n=39; 46%), online communication (n=22; 26%) virtual appointments (n=15; 18%). Other technologies included electronic patient records (n=5, 6%), e-Prescribing (n=3; 3%), and for PPE (n=1, 1%). Usability of systems varied significantly across types of technology. Barriers to successful use included accessibility to effective infrastructure.

Conclusion: there was a range and breadth of digital technologies adopted and used by nurses during the pandemic. There are ongoing issues with the availability of digital infrastructure to enable effective digital working, and poor usability of some systems that have been implemented.

Introduction

Technology and the use of data are now integral components of regular patient care, which pervade and influence nursing practice (Royal College of Nursing, 2018). This increase in technology-driven nursing and the potential for improved efficiency should give staff more time to care (Royal College of Nursing, 2018), 'promoting deeper interaction with patients' (Topol, 2019). The NHS Long Term Plan (Department of Health and Social Care, 2019) expects all NHS organisations to advance to a core level of digitalisation by 2024, with healthcare professionals, including nurses, using digital technologies to support patient care (Department of Health and Social Care, 2019). The adoption of digital technologies was accelerated during the COVID-19 pandemic, with anecdotal evidence that nurses have transformed their approach to patient/client care, integrating digital technology to support their work in response (Green, 2020). Nurses play a significant role in coordinating care and liaising with other health and social care professionals (Havens DS, 2010; Williamson S, 2012) and identified as a key in the successful deployment and use of digital health technologies, for example using telehealth to provide monitoring and support remotely to patients with chronic diseases (Booth et al., 2021). It is therefore important to understand how the rapid changes to digital technology uptake during the pandemic have affected the nursing workforce.

Nurses' adoption of technology prior to the COVID-19 pandemic

As early as 2004, in an analysis of responses to a UK wide online survey of nurses the Royal College of Nursing (RCN) highlighted how nurses wanted to see integrated electronic clinical records that enabled access to updated patient data (Royal College of Nursing, 2004). They also wanted the facility to share data across organisational boundaries, and to be consulted as 'end users' about new technologies being implemented. However, they highlighted

challenges with the systems they were using, identifying inadequate and old IT equipment, a lack of access to equipment and to the internet, and where they did have access, it was to computer equipment that was much older and slower than they used at home or university (Royal College of Nursing, 2004). Similar issues of challenges with digital infrastructure were highlighted by Zuzelo et al. (2008), with nurses commenting that the structure and infrastructure of buildings impacted care; they struggled to use technology in older areas of hospital buildings that were not constructed to accommodate the deployment of digital technologies.

As well as issues related to digital infrastructure, nurses' digital literacy (capability to use technology in their practice) and poor usability of the systems they are asked to adopt, often due to the lack of consultation with nurses on their design and use can affect how technology systems are used in clinical practice (Abimbola et al., 2019; Brown et al., 2020). There are significant implications for the quality of patient care if digital systems have poor usability or fail to take into account nurses' work. For example nurses may resort to paper when computers fail or during emergency situations that need multiple screens, which can impair the process of delivering safe patient care (Schoville, 2009). This practice can lead to the duplication of documents (Royal College of Nursing, 2018), risking anomalies in patient data due to inconsistent transfer or the misplacing of paper records (Rantz et al., 2011; Schoville, 2009).

Consistently, concerns have been raised about the lack of involvement of nurses in designing technology systems. It has been suggested that vendors fail to understand how to support nurses' work or their critical thinking and decision-making (Staggers et al., 2018), and they are often not at the table when decisions about technology are made (Lavin et al., 2015;

Mather et al., 2019). For example, the electronic health record is designed for a single patient in a linear workflow, yet most nurses care for more than one patient, and this design oversight leads to nurses using memos as additional tools. They may have to log data that is not related to their role, such as for regulatory or auditing purposes, rather than concentrating on what they need to do to provide good nursing care (Staggers et al., 2018).

In addition, poor interoperability between systems limits the possibility of nurses adopting technologies, and the continued failure of joined-up recording of patient data impairs current and future practice (Justinia, 2017; Koch et al., 2012; Taylor et al., 2015). For example poor integration of information across multiple devices can lead to increased medication errors, and issues of poor communication of patient data between care providers is consistently identified as a risk to patient safety (Koch et al., 2012; Troyer and Brady, 2020). Implementations that result in varying levels of success or failure can leave staff reluctant to adopt new technologies, demoralised, or holding differing valuations of the same digital tool (Jardiel and Harniess, 2021; Taylor et al., 2015). Where technology is insufficiently integrated, nurses themselves must draw the data together to make sense of patient care (Koch et al., 2012).

Implications for the adoption of technology by nurses during the COVID-19 pandemic

When nurses are meaningfully involved in technology implementation and are given practical training, they can see and value the benefits to themselves and to patients (Beaney et al., 2019; de Veer et al., 2011). In addition, when they perceive that a system is working well and that the positives outweigh the problems, they are more likely to engage in successfully adopting the technology (Dowding et al., 2015). It is important to understand how the rapid adoption of technology solutions during the COVID-19 pandemic interacted with the often

poorly designed systems used preceding the pandemic, which impacts patient care and nurse workflow (Dykes and Chu, 2020). Pre-pandemic assessments of tools such as barcode scanners and e-prescribing systems reveal how malfunctions can lead to workarounds, where nurses use technology systems in ways not originally envisaged by the developer, to overcome limitations of the system (Cresswell et al., 2013; Cresswell et al., 2017; Gann, 2015). For example, nurses may give a medication without scanning a patient bar code first or scanning patient ID barcodes that are not on the patient (and may be in the nurse's pocket, on another object or attached to a sheet of paper)(Fraczkowski et al., 2020). Improving technology for medicines management can reduce nurses' cognitive and physical workload (Koch et al., 2012). During the COVID-19 pandemic these workarounds became more complex as nursing staff had to change into and out of personal protective equipment (PPE), with COVID-19 'underscoring the poor usability of healthcare technology across the care continuum' (Dykes and Chu, 2020).

Aim

To explore nurses' adoption and use of digital technologies during the COVID-19 pandemic.

Method

We designed an online scoping survey that targeted nurses based in the United Kingdom (UK) working across all health and social care sectors (including acute care, community care, social care, mental health, primary care). The survey sought nurses' feedback and ratings of the technologies implemented in their units and services to support patient care during the pandemic. Survey questions were developed by a team comprising nurses and academics, and with the input of two PPI (patient and public involvement) representatives, using the *Non-adoption, abandonment, scale-up, spread, sustainability* (NASSS) framework as a guide (Greenhalgh et al., 2017). The study team gave several rounds of feedback on the survey

questions, and the survey was piloted with 10 nurses involved in digital and informatics roles. Some survey questions were revised following feedback from the pilot, giving a final instrument subsequently used for data collection.

The final survey questions were uploaded to Qualtrics XM, a web-based survey tool that is securely accessed through a 2-factor authentication log-in. In total, the survey had 41 questions covering demographics, digital technologies that had recently been adopted into the respondents' services (up to three), and a final optional section on nurses' broader attitudes to healthcare technology. Hence, the time required to complete the survey was dependent on how many technologies a respondent chose to rate, and if they opted to answer the final questions. A participant information sheet was provided at the start of the survey which explained that anonymised data would be used in publications and abstracts as part of conference proceedings. Respondents were also informed that they could withdraw from the study without completing the survey. However if they did complete and submit the survey their data could not then be removed as it was anonymised. Respondents had to indicate via a tick box that they consented to participate before they could move on to the survey questions. The survey contained fixed response and free-text questions as well as a rating of the usability of the technology being reported on by the respondent known as the System Usability Scale (SUS) (https://www.usability.gov/how-to-and-tools/methods/system-usability-scale.html). Usability is the process of making systems easier to use and matching them to the needs of the person using the system. The SUS scale comprises 10 questions that ask respondents to provide a response from Strongly Agree to Strongly Disagree and is scored between 0 – 100, with a higher score indicating a system that is easier to use. In general an SUS score above 70 indicates good usability (Bangor et al., 2009).

The survey was classified as a service evaluation by The University of Manchester and therefore ethical approval was not required.

Recruitment

A call for participants and a link to the survey were supplied to gatekeepers of professional nursing networks who, at their discretion, shared the material on professional platforms and similar networked social media sites. The call specified that nurses who were UK-based and who had been using digital technologies for patient care during the pandemic were invited to follow the link and complete the survey. Once respondents had started the survey, they could revisit it for up to 2 weeks to complete it. No incentive was offered to respondents. The original plan, to run the survey for 4 weeks, was extended to give nurses ample opportunity to complete partially finished surveys, and final reminders were sent out to nursing networks to promote the survey. In total the survey ran for 5 weeks and 4 days during October-November 2021.

Analysis

Responses to closed questions were analysed using descriptive statistics. The scale for the SUS was converted into numbers (1= strongly disagree through to 5=strongly agree). SUS scores were then calculated using the method proposed by Brooke (1996); the SUS Score equals (X+Y) x 2.5, where X=sum of score for all odd-numbered questions -5 and Y=25-sum of score for all even-numbered questions.

Results

Overall, 135 individuals started to respond to the survey, of whom 55 (40%) provided information about at least one technology and were included in the final analysis. The majority of respondents worked in an acute trust in the UK (n=38; 69.1%), with a small

number working in GP or primary care practices (n=4; 7.3%), or for specialist providers (n=3; 5.5%). One respondent worked in a community care organisation, 1 worked in a mental health trust and 8 (14.6%) worked in other types of organisation. Just over half of the organisations (n=31, 56.4%) had a dedicated team of nurses/others responsible for digital technologies for nursing.

The 55 respondents provided details on 85 separate technologies. Technologies were more likely to be stand-alone systems (n=44, 52%) and have been introduced into the organisation during the pandemic (n=56, 66%). Nurses were reported to be the main users of the technologies (n= 76; 89%), followed by doctors (n=56; 66%) and patients (n=42; 50%). The majority of systems were either a vendor system (n=25; 29%) or provided by a health care specialist software company (n=24; 28%). Systems had a number of features including to support decision-making (n=45; 53%), enable remote monitoring of patients (n=39; 46%), support real-time consultation/communication with colleagues (n=41; 48%) and support real-time consultation/communication with patients (n=39; 46%). A few systems enabled patients to enter data into their own records (n=14; 17%), share information between organisations (n=12; 14%) and manage medicines/prescriptions (n=11; 13%).

Respondents felt the technology addressed the needs of a diverse patient population most or some of the time (n=79; 93%), and that they were not aware of patients expressing concerns about the technology being used in their care (n=63; 74%). They felt the technology enabled the continuance of patient care during the pandemic (n=64; 75%) and thought they would continue to use the technology post pandemic (n=69; 81%).

The mean SUS score was 69.8 (range 20-100; SD 19.5).

Types of technology

Based on the survey responses, the technologies identified by participants were categorised according to their main function (Table 1). Most technologies were used either for patient monitoring/data sharing (n=39; 46%), for online communication (n=22; 26%) or virtual appointments (n=15; 18%).

Table 1: Technology Types

Type of Technology (main function)	**N (%)**
E-prescribing	3 (3.5)
Electronic patient records	5 (5.9%)
Online communication	22 (25.9%)
PPE*	1 (1.2)
Patient monitoring/data sharing	39 (45.9)
Virtual appointments	15 (17.6)
Total	**85 (100)**

*****Identified by respondent as a technology to support PPE distribution

There were variations in the types of technologies reportedly being used according to the type of organisation. Nurses working in GP/primary care were more likely to be using e-prescribing (n=2; 66.7%) and nurses in acute trusts were more likely to be using electronic patient record systems (n=5; 100%), patient monitoring/data sharing (n=28; 71.8%) and virtual appointment (n=10; 66.7%) technologies. Online communication technologies were reported to have been used across all organisations.

There was some variation in technology characteristics by technology type. All 8 e-prescribing and electronic patient record systems were integrated into existing systems compared to systems for online communications and virtual appointments, where 14 of the 22 online communication (63.6%) and 11 of the 15 virtual appointment (73.3%) were stand-alone systems. Systems that focused on patient monitoring/data sharing were equally as likely to be integrated or stand-alone.

Online communication (68.2%, 15 of 22), patient monitoring/data sharing (61.5%, 24 of 39) and virtual appointment systems (86.7%, 13 of 15) were all more likely to have been introduced (being new to the organisation) during the pandemic. Whilst there were no obvious patterns for different types of system and targeted users, or suppliers of systems (with a spread across commercial and home-grown systems), very few of the systems enabled patients to enter their own data or share data across organisations. The exception was patient monitoring systems, where 28.2 % (11/39) allowed patients to enter data and 23.1% (9/39) enabled data sharing across organisations. The majority of online communication systems supported communication with colleagues (86.4%, 19/22) whereas patient monitoring/data sharing systems enabled remote monitoring of patients (69.2%, 27/39) and supported real time communication with patients (38.5%, 15/39). Both online communication systems and patient monitoring/data sharing systems supported decision-making (54.5%, 12/22 and 61.5%, 24/39 respectively).

Overall users of online communication and virtual appointment technologies were less likely to report that they and their colleagues had received sufficient training to use the systems. Factors other than training needs impacted technology use among 68.2% of respondents. They were asked to describe the factors they thought were relevant in a free-text box and a

sample of the responses are itemised in Table 2 according to the technology category they relate to.

Technology	Factors impacting use
E-prescribing	• Computer literacy, availability of devices
Electronic patient records	• Speed of system, accessibility of devices • Inconsistent quality we have had to stop implementing multiple times • Not set up as user friendly • Network link issues for satellite units • Problems with local network leading to unplanned downtime
Online communication	• Digital literacy and knowledge of software use • Access to computers and issues with Wi-Fi. Time away from clinical duties to attend training • Accessibility of smart phones, some staff can't afford these • Lack of time to enable adequate use of this technology and service for patients • Lack of understanding as to how the system works and its capabilities • Some people are more open to the use of new tech, and others are nervous of its introduction • IT equipment, network reliability • Competencies and resourcing of ICT staff, culture change needed • Time pressures • Individual patient training needs • Connectivity issues, especially with staff working from home / remote locations • Differing levels of computer literacy with… sharing screen, mute, camera on/off • Varied levels of expertise and confidence in using remote patient reviews and consultations • Hospital bandwidth to the internet (severely limited) • Lack of private spaces for communication • Varied knowledge of public health approaches
PPE	• Comfort and ease of use

Patient monitoring/data sharing	• Staff familiarity with the clinical system. May not use to best advantage • The input devices vary and all carry challenges in practice, that is using tablets, laptops on wheels or PCs • Access to devices to use the tool, we vary from computers/WOW [workstation on wheels]/ iPads • Being able to provide temp staff with temp passwords is a huge issue. So they can both input data and view data stored about their allocated patients. • Unstable platform initially, Wi-Fi and hardware availability made adoption difficult • System at times does not do what is required of it • Computer literacy and dependence on outside team maintaining the IT system • Not all staff keen to use technology • Multiple uses of programme only allows one user at a time • Hardware not updated to cope with new systems • The system was a basic platform of information meaning [that] to gain greater impact on use from the technology was having the clinical knowledge & experience essential • Team members and patient capability with technology and availability of smart phone/able to use/ already having NHS app downloaded
Virtual appointments	• Time to deliver virtual visiting during pandemic surges • Confidence using camera, concerns re potentially others in background on video/confidentiality • Different levels of commitment • Quality of internet connection/ telephone connection • Digital literacy, cumbersome setup/access

Table 2: Examples of factors impacting on technology use

Usability of technology systems

SUS scores varied across the different technology types (Figure 1 and Table 3), with E-prescribing systems having the highest mean usability score (90; SD 10.6) and electronic patient records the lowest (49.4; SD 20.2). There was significant variation in SUS scores within technology type; for example, the lowest SUS score for patient monitoring/data sharing was 30 (which would indicate very poor usability) through to 100 (which would indicate the best usability).

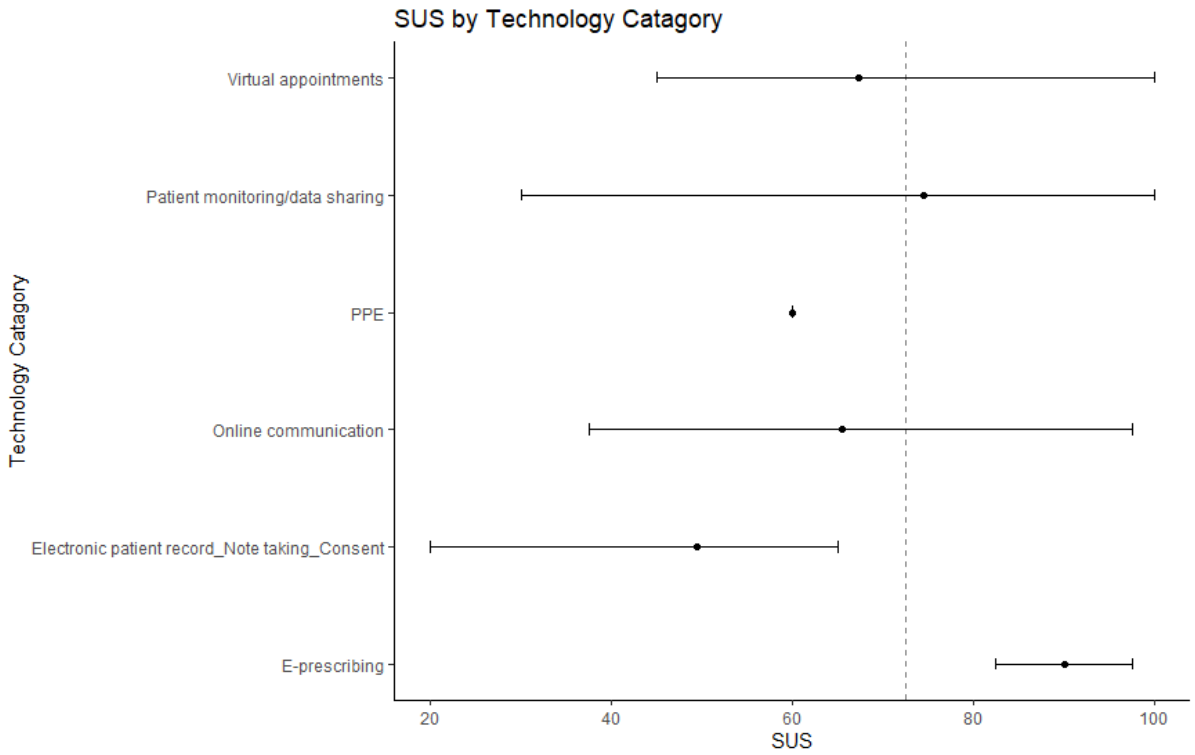

Figure 1: SUS Score with 95% Confidence Intervals by technology type

Table 3: SUS scores by technology type

Type of Technology (main function)	Range	Mean SUS score (SD)
E-prescribing	82.5-97.5	90 (10.6)
Electronic patient records	20-65	49.4 (20.2)
Online communication	37.5-97.5	65.5 (17.6)
PPE	-	60
Patient monitoring/data sharing	30-100	74.5 (19.5)
Virtual appointments	45-100	67.3 (18.6)

Limitations

The survey was conducted online, and recruitment was via professional networks and social media adverts. This means that the individuals who responded may not be representative of the wider nurse population, as they would have a baseline level of technological awareness. In addition, we had a number of individuals who started the survey, but did not complete it (n=80), of whom a small but significant number were from community care organisations (of the 10 individuals from this type of organisation only 1 completed the survey). The majority

of respondents worked in acute trusts in the UK, and therefore the picture of digital technology adoption and use that our survey provides may be skewed towards the experiences of nurses working in this sector and this country.

Discussion

The aim of the survey was to explore nurses' experiences of using digital technologies during the COVID-19 pandemic, when the use of digital solutions increased significantly across the health and social care sectors. We found that a range of technologies had been adopted and were being used by nurses. Many of the technologies that they reported on were introduced to support communication (across colleagues, and between patients and health care staff) and for remote patient monitoring once social distancing rules were instigated to reduce COVID-19 transmission rates. A number of the technologies were integrated with existing systems; however, over half were stand-alone systems. We can only truly get the benefits of digital working when the systems used by nurses can be consistently shared across organisations, and there are well documented challenges with nurses (and other health care professionals) having to use a myriad of different digital systems, or a hybrid working model of paper plus technology. This diversity of systems can lead to complexity, resulting in nurses having to work around technological barriers, or needing to take extra steps to complete tasks. Ways of improving the utility and sustainability of technology implementation is to reduce complexity and improved integration with workflows, so that workarounds become unnecessary need addressing (Greenhalgh et al. 2017).

One area of significant concern related to our findings, was nurses' reports of the factors that inhibited their ability to use the digital technologies that had been adopted effectively. Whilst lack of specific training on some types of system was apparent, overall, their report of issues such as poor digital infrastructure and lack of availability of devices was striking. These

issues were highlighted as barriers to digital technology adoption by the RCN in 2004 (Royal College of Nursing, 2004), and it is concerning that this remains a significant barrier 18 years later. If NHS organisations are to be fully digital and paperless by 2024 (Department of Health and Social Care, 2019), resources need to be provided to ensure that the infrastructure can support this new way of working.

We also found significant variability in the reported usability of technology systems being used by nurses. Some systems, particularly those introduced to support electronic prescribing, had extremely high usability (with SUS scores ranging from 82.5 to 97.5). However, all of the other types of technology had a wide variation in their reported usability, with some scoring as low as 20 (electronic patient record), 30 (patient monitoring/data sharing) and 37.5 (online communication). This variability in SUS scores across system types indicates a lack of consensus across health and social care organisations on the technology systems being procured or developed to support nursing practice and what a 'good' or usable system may look like. Of particular concern is the low usability scores for electronic patient records; none of the systems had an SUS score above 70 (the industry standard for acceptable usability), and they had the lowest overall mean SUS score. As highlighted in the introduction, nurses are often not involved in the design of systems that they are asked to use in practice, leading to issues with usability (Greenhalgh et al., 2017). The results of our survey suggest that this is an ongoing issue, and something that needs to be addressed if we are to enable nurses to integrate patient data into their work.

Despite the issues that nurses raised in the survey about the digital infrastructure and system usability, it was noticeable that the majority of nurses were positive both about the impact

using digital technologies had provided to enable continuity of care during the pandemic, and that they were keen to continue to use the technology going forward.

Conclusion

The survey results reveal the range and breadth of digital technologies adopted and used by nurses to support caring for patients during the recent COVID-19 pandemic. They also highlight ongoing issues with the availability of digital infrastructure to enable effective digital working, and the poor usability of some of the systems that have been implemented. In order to achieve the ambition of the NHS long term plan (Department of Health and Social Care, 2019), these factors need to be addressed. Identifying those digital systems that have been recognised as having high usability, and providing details on this for the benefit of other health and social care organisations, could assist with the adoption and use of technology in nursing in the future.

Implications for Practice

- Nurses need access to reliable and efficient digital infrastructure (e.g. network/Wi-Fi access and devices) to support effective use of technology in practice
- Organisations need to share details on technology systems that have high usability for clinical nurses, to enable all practitioners to benefit from using such systems
- In order to fully develop the potential of digital working, further work on integrating digital technologies across health care organisations can improve effective working.

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